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POTASSIUM REQUIREMENT OF ULTRA NARROW AND CONVENTIONALLY SPACED COTTON AS IMPACTED BY TILLAGE

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Abstract

Potassium (K) needs for conventional spaced (30 to 40-inch row) cotton (*Gossypium hirsutum* L.) have been well researched and established, but there has been no published data on K requirements of ultra-narrow row (UNR) cotton. We conducted a replicated 3 year study on a Lucedale sandy loam (Rhodic Paleudults) in central AL to determine the potassium (K) need of cotton, as impacted by row spacing and tillage system. Treatments were a factorial arrangement of K fertilizer rate (long-term applications of 0, 30, or 60 lb K_2O/A), row spacing (8-inch UNR or 36-inch conventional), and tillage system (chisel disk or no-tillage). Cotton lint yields ranged from 142 to 1253 lb lint/acre during the 3 year study, depending on season and treatment combinations. Ultra-narrow row cotton consistently resulted in substantial yield increases compared to conventional row spacing (98% increase, averaged over tillage, K rates and years). Ultra-narrow row cotton yield response to K fertilizer was similar to that of cotton grown in conventional row widths and UNR spacing with adequate K fertilization (to 60 lb K_2O/A), consistently provided the highest yield. In two of three years, this row spacing-K fertilizer combination was optimized with no-tillage. Fiber quality, as determined from High Volume Instrumentation (HVI), varied with year, row spacing, tillage, and K fertilization. Adequate K (60 lb K_2O/acre on this soil) was required to maintain micronaire readings, especially with UNR cotton and/or no-tillage cotton. Although it remains to be seen whether UNR cotton will be accepted by the market, our results suggest that adequate K nutrition is critical to optimize yield levels and fiber quality of UNR cotton.

Introduction

There is intense interest in ultra-narrow row (UNR) cotton production, but little information is available on fertility requirements, including potassium (K), for this production system. Because of higher plant populations, smaller plants with reduced root systems, and removal of a higher proportion of burs (which contain high amounts of potassium) with stripper harvesters compared to spindle harvesters, K fertility management may be different for UNR cotton than for cotton grown in conventional (30 to 40 inch) spacings. Tillage system effects on root distribution and soil water may also impact K fertilization needs.

Materials and Methods

A field study was conducted for 3 years (1998-2000) in central Alabama on a Lucedale sandy loam (fine-loamy, siliceous, subactive, thermic, Rhodic Paleudults) to compare the response of UNR (8-inch drill spacing) cotton to that of conventionally spaced cotton (36-inch rows) with respect to K fertility. The experimental design was a randomized complete block design with a factorial arrangement of K fertilizer rate, row spacing, and tillage system with a minimum of five replications for each treatment combination used. The study site had extreme variations in soil K levels due to annual applications of 0, 30 and 60 lb K_2O/acre beginning 7 years prior to initiation of the study; during the 3 years of the study, these annual rates of K were maintained. Tillage treatments included conventional tillage (disk, chisel, disk, level) and no-tillage with a high-residue producing rye (*Secale cereale* L.) cover crop. Varieties were Paymaster 1220 BG/RR cotton in 1998 and 1999 and Sure-Grow 125 BR in 2000. Planting dates were June 19 (replanted from May 19 due to poor germination) in 1998, May 12 in 1999 and May 23 in 2000. Seeding rates were 50,000 to 75,000 seed/A for conventional row spacings and 170,000 to 200,000 seed/A for UNR. Potassium treatments and Extension recommendations for N (90 lb N/A as ammonium nitrate) were broadcast prior to planting cotton each year. The UNR plots were harvested using an Allis-Chalmers 760XTB stripper modified for experimental plots and conventional row plots were harvested with a John Deere 9920 spindle picker. Subsamples (~2 lb) of seed cotton were processed through a 20-saw laboratory gin (Porter Morrison & Son, Dennis Manufacturing Co., Athens, TX 75751) to obtain lint turnout. Ginned samples were subjected to HVI analysis by the Auburn University Textile Engineering Fiber Physical Testing Laboratory. Data were subjected to ANOVA as a RCB model with a factorial arrangement of row spacing, tillage, and K rates. A significance level of $P \leq 0.10$ was chosen *a priori*. Data reported here include yield and HVI analyses.

Results and Discussion

Cotton Yield

Cotton lint yields ranged from 147 to 1253 lb lint/acre during the 3 year study, depending on season and treatment combinations. In 1998, the 36-inch row cotton failed to obtain a satisfactory stand, despite replanting twice, due to an extremely dry spring. Ultra-narrow row cotton yields increased with K fertilization. Lint yield averaged 505 lb/A with 0-K, 706 lb/A with 30 lb K_20/A, and 735 lb/A with 60 lb K_20/A. Highest UNR cotton yield (773 lb/A) was obtained with no-tillage and 60 lb K_20/acre.

In 1999 bronze wilt was observed in many plots in late July and early August. No-tillage yields were reduced due to plant stand loss from seedling disease, as good stands were initially observed in the rye cover, but decreased within two weeks after emergence. There was a row spacing *x* tillage interaction in that yields with no-tillage were reduced more in 36-inch row cotton than with UNR spacing. Yields for the 36-inch row width averaged 294 lb lint/acre for no-tillage cotton and 736 lb/acre for conventional tillage cotton. Within UNR plantings, no-tillage yields averaged 829 lb/acre and conventionally tilled cotton averaged 1110 lb/acre. Lint yield increased with K rate, averaging 665, 813, and 916 lb/A for the 0, 30, and 60 lb K_20/acre rates, respectively. Highest yields (1253 lb lint/acre) were obtained with conventionally tilled UNR cotton supplied with 60 lb K_2O/acre. Lowest yields were obtained with the 36-inch no-tillage cotton with no K fertilizer (242 lb/acre).

In 2000, under the worst drought in 50 years, highest lint yields were obtained with UNR cotton (571 lb/A averaged over tillage and K rate). Conventionally spaced 36-inch cotton averaged 288 lb/A. No-tillage averaged across row spacings yielded 580 lb lint/acre while conventional tillage averaged 344 lb/acre. Potassium fertilizer increased yields (359 lb/A with 0-K, 488 lb/A with 30 lb K_20/acre, and 505 lb/A with 60 lb K_20/acre, respectively). Highest yields were obtained with UNR no-tillage and 60 lb K_2O/acre (772 lb/acre) and lowest yields were obtained with the conventional tilled 36-inch spacing cotton with no K fertilizer (147 lb/acre).

HVI Analyses

In 1998, due to stand failure in the conventional row spacings, only UNR cotton samples were subjected to HVI analysis. Addition of 30 lb K_2O/acre increased gin turnout (32.5% for 0-K, 33.80 % for 30 lb K_2O/acre, and 33.8% for 60 lb K_2O/acre). Similar effects were found for micronaire. Micronaire averaged 3.28, 3.63, and 3.65 for the 0, 30, and 60 lb K_2O/acre fertilization, respectively. Potassium fertilization was required to maintain micronaire in the base (non-discount) range. Conventional tillage also increased micronaire of UNR cotton compared to no-tillage (3.72 vs. 3.30). No-tillage UNR cotton micronaire fell within the discount range and conventional tillage UNR micronaire was within the premium range. Tillage also affected length, uniformity, fiber strength, and HVI trash grade. Conventional UNR averaged 1.12 inches vs. 1.07 inches for no-tillage managed UNR. HVI length uniformity index averaged 83.6 % for conventional tillage vs. 82.5% for no-tillage. Strength was increased with conventional tillage compared to no-tillage (31.23 g/tex vs. 29.73 g/tex). There was a tillage *x* K rate interaction for trash grade. Potassium had no effect on trash grade with conventional tillage, averaging 7.8, 7.8, and 7.7 for the 0, 30, and 60 lb K_2O/acre, but in no-tillage UNR, trash grade increased from 6.2 with 30 lb K_2O/acre to 7.2 with 60 lb K_2O/acre.

In 1999, only the UNR cotton was subjected to HVI analysis, as the conventional row spacing seed cotton samples were not saved. Gin turnout was estimated for the conventional spacing cotton from the mean turnout of the Alabama Agricultural Experiment Station (AAES) variety trials at the station (38.0%). Within the UNR plots, there was a tillage *x* K fertilization effect on gin turnout. Within the conventionally tilled UNR, turnout averaged 29.8%, 31.0%, and 31.8 % with 0, 30, and 60 lb K_2O/acre, respectively. With no-tillage, turnout averaged 30%, 31.1%, and 31.0 % with 0, 30, and 60 lb K_2O/acre, respectively. There was also a tillage *x* K rate interaction on fiber strength and micronaire. Strength was decreased with the 60 lb K_2O/acre for conventional tillage UNR cotton but increased with this K rate under no-tillage. Strength averaged 30.1 g/tex, 30.1 g/tex and 28.9 g/tex with 0, 30, and 60 lb K_2O/acre, respectively, with conventionally tilled UNR cotton, versus 29.9 g/tex, 29.8 g/tex, and 31.1 g/tex with 0, 30, and 60 lb K_2O/acre, respectively, under no-tillage. As in 1998, K fertilization maintained micronaire above the discount range. Micronaire averaged 3.19, 3.50, and 3.58 with 0, 30, and 60 lb K_2O/acre, respectively, under no-tillage and 3.03, 3.58, and 3.84, respectively, with conventional tillage. Trash grade increased with K rate, averaging 7.5, 7.9, and 8.2 with 0, 30, and 60 lb K_2O/acre, respectively. K fertilizer also increased HVI length uniformity, averaging 79.6%, 80.1%, and 81.0% with 0, 30, and 60 lb K_2O/acre, respectively, regardless of tillage.

The 2000 season was the only season where a complete set of samples were subjected to HVI analysis. Conventional 36-inch row cotton ginned 37.7% and UNR cotton ginned 31.6% turnout. Trash grade was higher for UNR cotton than for conventionally spaced cotton in 36-inch rows (6.4 vs. 5.7). Increasing K rates increased turnout, regardless of tillage or row spacing, averaging 33.1%, 34.7%, and 35.0% for 0, 30, and 60 lb K_2O/acre, respectively. Micronaire was higher with UNR (4.38) than with conventional spaced cotton (4.20). As in 1999, there was a tillage *x* K rate interaction on micronaire. Micronaire averaged 3.75, 4.49, and 4.59 with 0, 30, and 60 lb K_2O/acre, respectively, with no-tillage and 4.1, 4.4, and 4.5 with 0, 30, and 60 lb K_2O/acre, respectively, under conventional tillage. Fiber length was also impacted by a tillage *x* K rate interaction. Length averaged 1.09, 1.07, and 1.09 inches

with 0, 30, and 60 lb K_2O/acre, respectively, under no-tillage and 1.07, 1.09, and 1.09 inches with 0, 30, and 60 lb K_2O/acre, for conventional tillage. Length was greater with conventional spaced 36-inch cotton (1.11 inches) than UNR cotton (1.07 inches). Strength was similarly affected by row spacing, averaging 26.96 g/tex for 36-inch spacings and 25.99 g/tex for UNR.

Summary

Ultra-narrow row cotton consistently resulted in substantial yield increases compared to conventional row spacing (98% increase, averaged over tillage and K rates and years). On this soil, UNR cotton yield response to K fertilizer was similar to that of cotton grown in conventional row widths. Ultra-narrow row spacing with adequate K fertilization (to 60 lb K_2O/A), consistently provided the highest yield. In two of three years, this row spacing-K fertilizer combination was optimized with no-tillage, while in one year, plant stand loss in UNR no-tillage favored higher yields with conventional tillage. Fiber quality, as determined from HVI, varied with year, row spacing, tillage, and K fertilization. Adequate K (60 lb K_2O/A on this soil) was required to maintain micronaire readings, especially with UNR cotton and/or no-tillage cotton. Within UNR cotton, no-tillage resulted in reduced micronaire compared to conventional tillage. Trash grade tended to increase with K rate, likely from reduced leaf senescence and reduced efficacy of defoliants. Although it remains to be seen whether UNR cotton will be accepted by the market, our results suggest adequate K nutrition is critical to maintain yield levels and fiber quality of UNR cotton.

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